REMARKS

Attached hereto is a marked-up version of the changes made to the specification and claims by the current amendment. The attached Appendix is captioned "**Version with markings to show changes made.**"

The Drawings were objected to under 37 C.F R. §1.84(p)(5) for failing to correspond to the Specification with regard to a reference sign. In response, the Specification (page 16, line 16) has been amended to make the reference sign S4 consistent in both the Specification and the Drawings. Accordingly, withdrawal of this drawing objection is respectfully requested.

The Specification and Claims have also been amended to correct for the minor informalities noted by the Examiner, as well as to place them in better form grammatically. No new matter has been added.

Claims 1-7 stand rejected under 35 U.S.C. §112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicant regards as the invention. Applicant has cancelled Claims 4-6, without prejudice, thereby rendering this rejection moot with respect to these claims. However, with respect to Claims 1-3 and 7, Applicant respectfully traverses this rejection.

The language of the claims has been changed to more clearly describe the present invention. These changes are merely cosmetic, and place the claims in better form grammatically, without altering their scope. Accordingly, as the claims are believed to be

clear for the purposes of 35 U.S.C. §112, Applicant respectfully requests the withdrawal of this rejection.

Claims 1-7 stand rejected under 35 U.S.C. §112, second paragraph, as being incomplete for omitting essential elements. Applicant has cancelled Claims 4-6, without prejudice, thereby rendering this rejection moot with respect to these claims. However, with respect to Claims 1-3 and 7, Applicant respectfully traverses this rejection.

Applicant respectfully submits that Claims 1-3 and 7 clearly define the present invention without omitting essential elements. Applicant respectfully submits that the phrase "If the underlayer film thickness is 2nm or less, a problem that sufficient magnetic characteristic cannot be obtained is generated . . ." (page 7, lines 7-10) was not intended to be an essential element of the invention. Instead, this phrase was merely provided as guidance to manufacturing a specific embodiment, as indicted by the previous sentence stating that "Film thickness of the underlayer 3 is determined within a wider range depending on various factors, but . . .". Further, the phrase about problems resulting with film thicknesses of 2nm or less does not state that the medium will not work at all with such a small thickness, but instead states that "sufficient" magnetic characteristics cannot be obtained. Thus, the phrase at issue was intended to describe a commercially practical product, and not to describe whether the medium can operate with an underlayer of such a small thickness. Accordingly, for these reasons, Applicant respectfully requests the withdrawal of this §112 rejection of Claims 1-3 and 7.

Claims 1 and 3-5 stand rejected under 35 U.S.C. §102(b) as being anticipated by United States Patent No. 5,759,617 to Mukai. Applicant has cancelled Claims 4 and 5, without prejudice, thereby rendering this rejection moot with respect to these claims. However, with respect to Claims 1 and 3, Applicant respectfully traverses this rejection.

Applicant respectfully submits that the Mukai reference fails to disclose all of the features of the present invention. Specifically, the Mukai reference fails to disclose a magnetic recording medium that includes, *inter alia*, a magnetic layer "wherein Cr is present only at the crystal grain boundaries of said alloy," as defined in independent Claim 1.

In one embodiment of the present invention, the magnetic layer is made from a Co alloy that lacks Cr. This magnetic layer is preferably laminated over an underlayer made of Cr or a Cr alloy. During a post annealing process, the Cr from the underlayer is induced into the magnetic layer, but this Cr is only found at the crystal grain boundaries. With such a configuration, the grain boundary region of the magnetic layer will not be magnetized, which results in a reduction in the mutual magnetic operation among the grains, whereby noise of the medium is reduced.

doesn't matter how [illegible] there

In contrast, the Mukai reference does not disclose that the Cr from the underlayer diffuses to the crystal grain boundaries, nor does it disclose that the magnetic layer only includes Cr at the crystal grain boundaries. Accordingly, as all of the features of independent Claim 1 are not disclosed in the Mukai reference, Applicant respectfully request the withdrawal of this §102(b) rejection of Claim 1 and associated dependent Claim 3.

Claims 4 and 5 stand rejected under 35 U.S.C. §102(b) as being anticipated by JP 8-329464. Applicant has cancelled Claims 4 and 5, without prejudice, thereby rendering this rejection moot.

Claim 2 stands rejected under 35 U.S.C. § 103 as being unpatentable over the Mukai reference. Applicant respectfully traverses this rejection.

Applicant respectfully submits that the Mukai reference fails to disclose or suggest all of the features defined in Claim 2. Specifically, the Mukai reference fails to disclose or suggest a magnetic recording medium that includes, *inter alia*, a magnetic layer consisting of a CoCr based alloy "including Cr in the concentration of 5at% or less," as defined in Claim 2. As correctly acknowledged by the Examiner, the Mukai reference does not specifically disclose this feature. Accordingly, the Examiner argues that it would have been obvious for one of ordinary skill in the art to have "optimized the amount of Cr diffused into the magnetic layer." Applicant respectfully disagrees.

As mentioned above, in one embodiment of the present invention, the magnetic layer is made from a Co alloy that lacks Cr. This magnetic layer is preferably laminated over an underlayer made of Cr or a Cr alloy. During a post annealing process, the Cr from the underlayer is induced into the magnetic layer (to make the claimed CoCr alloy), but this Cr is only found at the crystal grain boundaries. Since the Cr is only found at the crystal grain boundaries, the claimed Cr concentration of 5at%of less can be achieved.

Yes it does

In contrast, as mentioned above, the Mukai reference does not disclose that the Cr from the underlayer diffuses to the magnetic layer, nor does it disclose that the magnetic

layer only includes Cr at the crystal grain boundaries. Accordingly, since the Cr of the Mukai reference does not appear to be limited to the crystal grain boundaries, such a low Cr concentration as defined in Claim 2 (5at% or less) would not have been obvious to one of ordinary skill in the art. Further, in prior art mediums, substantial amounts of Cr were often included in the magnetic layer in order to reduce noise. Thus, to one of ordinary skill in the art, it would <u>not</u> have been obvious to have <u>reduced</u> the amount of Cr to such a low amount as that defined in Claim 2, since doing so could have increased the noise. Accordingly, since all of the features of independent Claim 1 are not disclosed or suggested in the Mukai reference, Applicant respectfully requests the withdrawal of this §103 rejection of Claim 2.

With the present invention, the present inventor found that one drawback of including a large amount of Cr in the magnetic layer is that the value of Ku is decreased. Accordingly, in the medium of the present invention, Cr is only found at the crystal grain boundaries (as defined in Claims 1 and 7), and is only present in a small amount (as defined in Claim 2). Thereby, the noise reduction benefits of Cr can be realized, without decreasing the value of Ku.

Claim 2 stands rejected under 35 U.S.C. § 103 as being unpatentable over JP 8-329464. Applicant respectfully traverses this rejection.

Applicant respectfully submits that the JP 8-329464 fails to disclose or suggest all of the features defined in Claim 2. Specifically, JP 8-329464 fails to disclose or suggest a magnetic recording medium that includes, *inter alia*, a magnetic layer consisting of a CoCr based alloy "including Cr in the concentration of 5at% or less," as defined in Claim 2. As

correctly acknowledged by the Examiner, JP 8-329464 does not specifically disclose this feature. Accordingly, the Examiner argues that it would have been obvious for one of ordinary skill in the art to have "optimized the amount of Cr diffused into the magnetic layer." Applicant respectfully disagrees.

Applicant respectfully submits that although JP 8-329464 states that the Cr is diffused into the magnetic layer, it does not state that the Cr content is limited to the crystal grain boundaries. Accordingly, Applicant respectfully submits that it would not have been obvious to one of ordinary skill in the art to have reduced the Cr amount to the low level (less than 5at%) defined in Claim 2. Thus, for at least this reason, Applicant respectfully requests the withdrawal of this § 103 rejection of Claim 2.

Claim 6 stands rejected under 35 U.S.C. § 103 as being unpatentable over the combination of Mukai and Marinero et al. and over the combination of JP 8-329464 and Marinero et al. Applicant respectfully submits that these rejections have been rendered moot by the cancellation of Claim 6.

Claim 7 stands rejected under 35 U.S.C. § 103 as being unpatentable over the Mukai reference in view of United States Patent No. 6,153,284 to Gui et al. Applicant respectfully traverses this rejection.

Applicant respectfully traverses this rejection for the same reasons discussed above when addressing the § 102(b) rejection of Claim 1 under the Mukai reference, and also because the Gui et al. reference fails to disclose or suggest the missing feature discussed above, nor was it relied upon for this feature.

Claim 7 stands rejected under 35 U.S.C. § 103 as being unpatentable over JP 8-329464 in view of United States Patent No. 6,153,284 to Gui et al. Applicant respectfully traverses this rejection.

Applicant respectfully traverses this rejection for the same reasons discussed above when addressing the § 102(b) rejection of Claim 1 under JP 8-329464, and also because the Gui et al. reference fails to disclose or suggest the missing feature discussed above, nor was it relied upon for this feature.

Claims 1 and 3 stand rejected under either 35 U.S.C. § 102(b) or under 35 U.S.C. §103 as being unpatentable over JP 8-329464. Applicant respectfully traverses this rejection.

Applicant respectfully submits that JP 8-329464 fails to disclose or suggest the present invention as defined in independent Claim 1. In particular, as correctly acknowledged by the Examiner, JP 8-329464 does not explicitly state that the Cr that diffuses into the magnetic layer is present only at the crystal grain boundaries. To remedy this deficiency, the Examiner has argued that the medium of JP 8-329464 inherently satisfies this feature because it is made by the same method as the claimed invention. Applicant respectfully disagrees.

In the medium of JP 8-329464, the CoSm magnetic layer is surrounded on both sides by a Cr layer (the Cr substratum and the Cr upper stratum), whereas in the present invention of Claim 1, the magnetic layer only includes a Cr underlayer positioned below it, and no second Cr layer above it. JP 8-329464 specifically states that the Cr upper stratum

diffuses CR into the magnetic layer (paragraph 0012). In addition, the Cr from the other Cr layer (the substratum) may also diffuse into the magnetic layer, which may result in more Cr diffusion than in the present invention, which includes only a single Cr layer.

In addition, the Cr substratum of JP 8-329464 appears to be of a thickness of 100nm (paragraph 0019), which is much larger than the 2nm-14nm underlayer of the present invention (page 7, lines 4-7). Such an increase in the thickness of the Cr layer positioned below the magnetic layer may also lead to an increase in the amount of Cr diffused, which could result in the Cr being diffused to areas other than the crystal grain boundaries.

Accordingly, as the medium of JP 8-329464 has been shown to include differences from the present invention of Claim 1 that may affect the manner in which the Cr diffuses into the magnetic layer, Applicant respectfully requests that this §102(b)/103 rejection of independent Claim 1 and associated dependent Claim 3 be withdrawn.

For all of the above reasons, Applicant requests reconsideration and allowance of the claimed invention. Should the Examiner be of the opinion that a telephone conference would aid in the prosecution of the application, or that outstanding issues exist, the Examiner is invited to contact the undersigned.

Respectfully submitted,

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

In the Specification:

The paragraph beginning on page 1, line 16 has been amended as follows:

As the recording density of a magnetic disc medium becomes high, an area of one bit on the medium is reduced. In such background, it is required, for acquisition of an output, to make ~~thinner~~ the magnetic layer thinner corresponding to a reduction in the size of a bit. Thereby, a semi-circular magnetic field can be assured and thereby leakage magnetic field generated from the magnetization area of one bit can be obtained. Moreover, since it is also required to narrow~~er~~ the bit interval, improvement in the magnetic domain structure in the magnetization transition area, scale-down of crystal grain corresponding to reduction in thickness and noise reduction by reduction in magnetic mutual operations among the particles or the like are necessary.

The paragraph beginning on page 2, line 6 has been amended as follows:

As a magnetic layer of a medium, a CoCr group alloy polycrystalline film formed of three or more elements has been used as a material of the magnetic layer. In the existing medium, Cr included in the magnetic grains of a magnetic layer is segregated into the crystal grain boundary and this grain boundary is non-magnetized to reduce mutual operation among the particles. In the related art, in order to promote this segregation, adding

coefficient of Cr to alloy is increased, Ta or the like is added and a substrate is also heated during the film forming process.

The paragraph beginning on page 2, line 17 has been amended as follows:

As explained above, while a means for segregating Cr included in the magnetic grains into the crystal grain boundary and non-magnetizing this grain boundary region is introduced, it is essential to use the CoCr group alloy magnetic material as a material of the magnetic layer. However, when reduction in thickness of magnetic layer and scale-down of crystal grains are promoted, a volume of individual magnetic grains is reduced, thermal disturbance is finally generated to result in the super-normal magnetization and the magnetic recording condition can no longer be maintained. In order to reduce the volume of individual magnetic grains as much as possible to a small amount, it is ~~the~~ best ~~means~~ to use a magnetic material having a higher anisotropic constant Ku. In the Co-based magnetic material, a value of Ku is lowered by as much as about one digit by adding Cr to the discrete element of Co. Therefore, use of the CoCr group alloy will make it very difficult to maintain the value of Ku. Moreover, the discrete element of Co will bring~~s~~ about a problem that corrosion proof characteristic is deteriorated.

The paragraph beginning on page 3, line 11 has been amended as follows:

An object of the present invention is to provide a magnetic recording medium having higher recording density. Moreover, another object of the present invention is to

realize <u>a </u>reduction in thickness of a magnetic film of a magnetic recording medium. Moreover, the other object of the present invention is to reduce noise of the magnetic recording medium itself.

The paragraph beginning on page 3, line 19 has been amended as follows:

In the present invention, unlike the CoCr group alloy used as a material of a magnetic layer, a Co-based alloy, where a non-magnetic element different from Cr is added to the Co discrete element, is used as a material of the magnetic layer. According to the present invention, reduction of the value of Ku due to the formation of alloy is controlled, and thereby a problem in reduction of thickness of magnetic layer in a magnetic recording medium can be solved.

The paragraph beginning on page 4, line 1 has been amended as follows:

However, when a Co-based alloy not including Cr is used as a material of <u>the</u> magnetic layer, Cr included in the magnetic grains is segregated into the crystal grain boundary and the grain boundary region can no longer be non-magnetized. Therefore, in the present invention, a Cr-based non-magnetic material is used as an underlayer. According to the present invention, the grain boundary region can be non-magnetized by segregating Cr to the crystal grain boundary from the underlayer. In ~~more~~ practic<u>e</u>~~al~~, diffusion of Cr into the crystal grain boundary of the magnetic layer from the underlayer is induced with post-annealing. As a result, the magnetic layer has a structure ~~that~~ <u>in which </u>Cr exists only at the

area near the crystal grain boundary, and thereby non-magnetization of the grain boundary region of the magnetic layer can be realized. Since the grain boundary region of the magnetic layer is non-magnetized, magnetic mutual operation among the grains can be reduced, and noise of magnetic recording medium can also be reduced.

The paragraph beginning on page 4, line 25 has been amended as follows:

Fig. 3 is a graph showing the relationship between the post-annealing temperature and magnetization characteristic.

The paragraph beginning on page 5, line 10 has been amended as follows:

Fig. 8 is a plan view of the magnetic disc drive as ~~the~~ an embodiment of the present invention.

The paragraph beginning on page 5, line 12 has been amended as follows:

Fig. 9 is a cross-sectional view of the magnetic disc drive of Fig. 8 as ~~the~~ an embodiment of the present invention.

The paragraph beginning on page 5, line 17 has been amended as follows:

Fig. 11 is a flowchart of the process to form a medium in ~~the~~ an embodiment of the present invention.

The paragraph beginning on page 5, line 26 has been amended as follows:

Fig. 1 is a cross-sectional view of a magnetic recording medium of the present invention. In the magnetic recording medium 1 of the present invention, an underlayer 3, a magnetic layer 4, and a protection layer 5 are sequentially formed on a substrate 2. Each film forming the magnetic recording medium 1 will be explained below.

The paragraph beginning on page 6, line 4 has been amended as follows:

The substrate 2 is formed of a non-magnetic material of a disc shape. A material forming the substrate 2 includes an NiP plated aluminum (including aluminum alloy) disc, a glass (including reinforced glass) disc, a silicon disc having a surface oxide film, an SiC disc, a carbon disc, a plastic disc, a ceramic disc or the like. Moreover, the substrate 2 is not always required to have completed the texture process. ~~A~~ The size of substrate 2 is determined depending on the kind of desired medium and magnetic disc drive as the application object or the like. In general, the external diameter is in the range of 65 mm to 95mm, the internal diameter is in the range of 20mm to 25mm and the thickness is in the range of 0.635mm to 0.8mm.

The paragraph beginning on page 6, line 18 has been amended as follows:

The underlayer 3 is formed of a non-magnetic metal material mainly composed of chromium. As ~~the~~ a practical ~~material~~matter, a metal material mainly composed of only chromium or chromium alloy such as CrW, CrV, CrTI, CrMo or the like may be ~~listed~~used.

The underlayer 3 is formed, for example, with ~~the~~ a sputtering method such as ~~the~~ magnetron sputtering ~~method~~ or the like. As ~~the~~ adequate film forming conditions, for example, the substrate temperature is 30 °C, the Ar gas pressure is 3 to 5mTorr, and the input power is 100 to 800W. Moreover, it is also possible to introduce, in place of the sputtering method, ~~the~~ other film forming methods, for example, ~~the~~ vacuum evaporation ~~method and~~ or ion beam sputtering ~~method~~ or the like. Film thickness of the underlayer 3 is determined within a wider range depending on various factors but the thickness is preferentially set within the range of 2nm to 14nm to improve S/N ratio. If the underlayer film thickness is 2nm or less, a problem that sufficient magnetic characteristic cannot be obtained is generated, and if thickness becomes 14nm or more, on the contrary, noise tends to be increased.

The paragraph beginning on page 7, line 12 has been amended as follows:

The magnetic layer 4 is formed of a Co-based alloy mainly composed of cobalt and an alloy where a non-magnetic material other than Cr is added to Co, for example, CoPt alloy and CoW alloy or the like are formed. It is preferable for the magnetic layer 4 that it is formed with ~~the~~ a sputtering method such as ~~the~~ magnetron sputtering ~~method~~ or the like and for example, the substrate temperature is set to 30 °C, as the adequate film forming conditions, Ar gas pressure is set to 3 to 5mTorr and input power is set to 100 to 800W. Moreover, ~~the~~ other film forming methods, such as vacuum evaporation ~~method~~ and ion beam sputtering ~~method~~ or the like may be used in place of the sputtering method.

The paragraph beginning on page 7, line 25 has been amended as follows:

The protection layer 5 is composed of a discrete carbon or a composite including carbon. For example, WC, SiC, B4C, carbon including hydrogen and a diamond like carbon (DLC) that is noted in such a point as having higher hardness may be listed. It is preferable ~~for~~ that the protection layer 6 ~~that it is~~ be formed with ~~the~~ a sputtering method such as ~~the~~ magnetron sputtering ~~method~~ or the like. As the preferable film forming conditions, for example, the substrate temperature is set to 30 °C , Ar gas pressure is set to 3 to 5mTorr and input power is set to 300 to 500W. Moreover, ~~the~~ other film forming methods such as vacuum evaporation ~~method~~ and ion beam sputtering ~~method~~ or the like can be substituted for the sputtering method. The thickness of the protection layer 6 is determined in a wider range depending on various factors, and the preferable thickness is in the range of 4nm to 8nm.

The paragraph beginning on page 8, line 15 has been amended as follows:

Here, it is also allowed that a lubricant film is formed on the protection layer. The lubricant film is usually composed of a ~~phlo~~fluororocarbon resin based material in the thickness of 1nm to 2nm.

The paragraph beginning on page 8, line 25 has been amended as follows:

In Fig. 2, a dotted line indicates the grain boundary, the region surrounded by a solid line is the region composed of a Co-based alloy (Cr is not included) and the region

surrounded by the dotted line and solid line is the region composed of a CoCr based alloy. From Fig. 2, it is understood that Cr is segregated only to the area near the crystal grain boundary with the post-annealing. Since Cr is diffused into the crystal grain boundary of the magnetic layer 4, magnetic mutual operation among the crystal grains of magnetic layer 4 is impeded. Thereby, generation of noise in the magnetic layer 4 can be controlled.

The paragraph beginning on page 9, line 10 has been amended as follows:

However, when the post-annealing is executed after formation of the protection layer 5 mainly composed of carbon as explained above, carbon reaches the surface of the underlayer 3 passing through the crystal grain boundary to form a film to impede diffusion to the grain boundary of magnetic layer 4 of Cr of the underlayer 3. Therefore, it is preferable to execute the post- annealing after the magnetic layer 4 is formed and before the protection layer 5 is formed. Moreover, <u>if</u> the magnetic layer 4 is exposed before the protection layer 5 is formed, ~~and~~ when the substrate 2 is exposed to the atmospheric condition under this condition, an oxide film is formed at the surface. Since this oxide film is condensed during the post-annealing to provide roughness of the surface, it is preferable that the post-annealing is conducted while the vacuum condition is maintained after lamination of the magnetic film 4.

The paragraph beginning on page 10, line 4 has been amended as follows:

As shown in Fig. 3, diffusion of Cr to the crystal grain boundary of the magnetic layer from the underlayer is induced at ~~the~~ temperatures higher than 350 °C. Moreover, it is also understood that the Hc/Hk value can be increased, while the anisotropic magnetic field Hk does not change, by setting the post-annealing temperature to 350 °C or higher. These results indicate that the mutual operations among grains are reduced and diffusion of Cr to the crystal grain boundary of magnetic layer is accelerated. In the post-annealing temperature region exceeding 30 °C, the Hc/Hk value becomes higher as the post-annealing temperature rises. Therefore, it can also be proved that segregation of Cr can be controlled depending on the post-annealing temperature.

The paragraph beginning on page 10, line 19 has been amended as follows:

Fig. 4 shows a growth process of magnetic grains of the magnetic layer. As the magnetic layer, CoCrPt is used, and as the underlayer, Cr is used.

The paragraph beginning on page 10, line 22 has been amended as follows:

For acceleration of segregation of Cr due to the post-annealing, it is effective to introduce a medium forming technique to laminate the underlayer and the magnetic layer with the sputtering method in place of the heat treatment of the substrate. In this technique, as shown in Fig. 4, since the forming condition in which one magnetic grain grows on one

crystal grain of the underlayer is realized, the plain size of the magnetic grains can be controlled with the plain size of the crystal grains of the underlayer.

The paragraph beginning on page 11, line 5 has been amended as follows:

Figs. 5(a) and 5(b) show ~~the~~ graphs indicating the relationship between the concentration of additives and anisotropic constant Ku in the Co based magnetic material. Fig. 5(a) is ~~the~~a graph where Pt is added as the additive, while Fig. 5(b) is ~~the~~ a graph where Cr is added as the additive. From Fig. 5(a) and 5(b), it can be understood that when the concentration of the additive becomes higher, Ku becomes lower than 4e + 6(erg/cc), which is the Ku value of discrete element of Co. However, a lowering degree in the case where Cr is added as the additive becomes larger than that in the case where Pt is added, and a higher reduction degree is indicated in the region where Cr concentration is 5at% or less. Therefore, if the CoCr based alloy is used for the magnetic layer, it is preferable to set the Cr concentration to 5at% or less, if possible, to 3at% or less where the Ku value which is higher than the half of Ku value of discrete element of Co can be obtained.

The paragraph beginning on page 11, line 23 has been amended as follows:

Fig. 6 is a graph indicating the relationship between the Cr to Pt ratio in CoCrPt (concentration of Co has the constant value of 78%) and the Ku value. From Fig. 6, it can be understood that the Ku value is lowered when a rate of Pt is decreased and a rate of Cr is increased. When the rate of Pt is 0 and additional coefficient of Cr is 22%, which is the

practical adding coefficient, Ku becomes 4e + 5(erg/cc) which is about 1/10 of the Ku value of discrete element of Co.

The paragraph beginning on page 12, line 5 has been amended as follows:

Fig. 7 is a graph showing the relationship between the adding coefficient of W in CoW and the Ku value. From Fig. 7, it can be understood that while the adding coefficient of W is in the range of 0 to 16at% ~~that~~ and when the adding coefficient of W is ~~higher~~increasing, the value of Ku becomes larger, but when the adding coefficient of W exceeds 16at%, the Ku value ~~is~~ rapidly decreases~~d~~. However, in CoCr, a Ku value higher than that in addition of Cr in the same concentration can be obtained. From Fig. 7, it can be ~~said preferable~~ seen that the concentration of W should preferably be 16at% or less when CoW is used for the magnetic layer.

The paragraph beginning on page 12, line 16 has been amended as follows:

As explained above, from the graphs of Fig. 5 to Fig. 7, it can be understood that the addition of Cr remarkably reduces the Ku value, and that reduction of the Ku value can be reduced or increased by adding Pt and W in place of Cr. When the discrete element of Co is used as the magnetic layer, a higher Ku value can be obtained as shown in Figs. 5(a) and 5(b), but simultaneously corrosion proof characteristic is deteriorated. Accordingly, it is required to enhance passivation but it is inferior for practical use. Moreover, when the magnetic material not including Cr is used, a problem is generated in which the grain

boundary region cannot be non-magnetized. But, this problem can be solved by inducing diffusion of Cr into the crystal grain boundary of the magnetic layer from the underlayer with ~~the~~ post- annealing, as explained above.

The paragraph beginning on page 13, line 5 has been amended as follows:

On the other hand, the present invention is also applied to the magnetic disc drive including the magnetic recording medium explained above, and an example of the magnetic disc drive is shown in Fig. 8 and Fig. 9. Fig. 8 is a plan view of the magnetic disc drive of the present invention under the condition that a cover is removed, while Fig. 9 is a cross-sectional view along the line A-A of Fig. 8.

The paragraph beginning on page 13, line 17 has been amended as follows:

Numeral 53 is an actuator supported to rotate on the base plate 51. One end of the actuator 53 is provided with a plurality of head arms 54 extending in the direction parallel to the recording surface of the magnetic disc 50.. One end of the head arm is provided with a spring arm. A slider 40 is mounted to the flexure part of spring arm 55 via an insulation film (not shown). The other end of actuator 53 is provided with a coil 57.

The paragraph beginning on page 13, line 26 has been amended as follows:

On the base plate 51, a magnetic circuit 58 formed of a permanent magnet and a yoke is provided and the coil 57 explained above is allocated within a magnetic gap of the

magnetic circuit 58. A voice coil motor (VCM) is structured with the magnetic circuit 458 and coil 57. Moreover, the upper part of base plate 51 is covered with a cover 59.

The paragraph beginning on page 14, line 6 has been amended as follows:

Operations of the magnetic disc drive explained above will ~~then~~ now be explained. While the magnetic disc 50 does not rotate, the slider 40 is in the stationary condition in contact with the saving zone of the magnetic disc 50. Next, when the magnetic disc drive 50 is rotated ~~with~~ by the spindle motor 52, the slider 40 is levitated from the disc surface, keeping a small gap with the air flow generated with rotation of the magnetic disc 50. When a current flows into the coil 57 while the slider is levitated, a propulsive force is generated in the coil 57 to rotate the actuator 53. The slider 40 moves to the position on the predetermined track of the magnetic disc 50 to read or write data from or to the disc.

The paragraph beginning on page 15, line 7 has been amended as follows:

As shown in Fig. 1, the cross-section of the medium A is formed of an underlayer 3, a magnetic layer 4 and a protection layer 5 laminated sequentially on a substrate 2. The manufacturing process of medium A is shown in Fig. 11. The manufacturing process of medium A will be explained with reference to Fig. 11.

S1: An underlayer 3 is laminated on a substrate 2 consisting of a Si disc ~~in the~~ with an external diameter of 6.5mm, an internal diameter of 20mm and a thickness of 0.635mm on which surface a silicon oxide film is formed in the thickness of 300nm. The underlayer 3 is

composed of a polycrystalline film of Cr. After the chamber of the sputtering apparatus is evacuated to 5e-10Torr, a film is formed in the thickness of 5nm on the substrate 2 under the condition that the Ar gas pressure in the sputtering chamber is set to 3mTorr.

S2: A magnetic layer 4 is laminated on the underlayer 3. The magnetic layer 4 is formed of a CoPt alloy polycrystalline film, and this film is formed in the thickness of 14nm on the underlayer 3 under the conditions that the Ar gas pressure in the sputtering chamber is set to 3mTorr and the input power is set to 100W. The magnetic layer 4 of medium A has the composition of cobalt of 88at% and platinum of 12at%.

The paragraph beginning on page 16, line 4 has been amended as follows:

On the occasion of forming a film of magnetic layer 4, a bias voltage is set to 0V in order to avoid the heat processing of the substrate. Moreover, in order to attain high purity of film, a partial pressure of oxidized gas element is reduced to 1e-11Torr or less by reducing the vacuum base pressure (1e-9Torr) and purifying the Ar gas.

S3: After the magnetic layer 4 is formed, the vacuum condition is held and the post-annealing is performed for 20 seconds at 450 °C to sufficiently induce the diffusion of Cr to the magnetic layer 4 from the underlayer 3.

S4~~5~~: A protection layer 5 is laminated on the magnetic layer 4. The protection layer 5 is formed after the post-annealing. This layer 5 is formed in the thickness of 5nm on the magnetic layer 4 under the conditions that the substrate temperature is 30 °C, the Ar gas pressure in the sputtering chamber is set to 3mTorr and the input power is set to 1000W.

The paragraph beginning on page 16, line 23 has been amended as follows:

From the medium A manufactured as explained above, a value of Ku of 3.7e+6(erg/cc) and a value of Hc/Hk of 0.44 have been obtained. The Ku value obtained here is larger than 8e+5(erg/cc), which is the value of Ku of the medium of which the magnetic layer is composed of Co66Cr22Pt12. Moreover, as the value of Hc/Hk, 0.44 has been obtained by reflecting the width of the non-magnetized region of the grain boundary portion formed with diffusion of Cr into the grain boundary of magnetic layer. From this result, it has been proved that sufficient grain boundary segregation of Cr can be realized even in the medium where Cr is not added to the magnetic layer. Here, it has also been confirmed that Cr exists only in the region within 3nm from the crystal grain boundary in the magnetic layer 4.

The paragraph beginning on page 17, line 12 has been amended as follows:

A structure of the layer of medium B is shown in Fig. 12. Unlike ~~the~~ medium A, ~~the~~ medium B has a magnetic layer 4' including Cr. The manufacturing process of medium B is shown in Fig. 13. The manufacturing process of medium B will be explained with reference to Fig. 13.

S11: An underlayer 3 is laminated on a substrate 2. The s~~S~~hape and material of the substrate 2 are identical to that of ~~the~~ medium A. The underlayer 3 is composed of the polycrystalline film of Cr and it is formed in the thickness of 5nm on the substrate under the conditions that the sputtering chamber is evacuated to 5e-Torr, the Ar gas pressure in the

sputtering chamber is set to 3mTorr and the input power is set to 100W.

S12: The substrate 2 is heated up to 250 °C.

S13: A magnetic layer 4 is formed on the underlayer 3. The magnetic layer 4' is composed of the CoCr group alloy magnetic material and it is formed on the underlayer 3 in the thickness of 14nm under the condition that the substrate 2 is heated, the Ar gas pressure in the sputtering chamber is set to 3mTorr and the input power is set to 100W. The composition of magnetic layer 4' of medium A has the composition of cobalt of 75at% and chromium of 13at%.

S14: A protection layer 5 is also formed on the magnetic layer 4'. The protection layer 5 is formed in the thickness of 5nm on the magnetic layer 4' under the conditions that the substrate temperature is set to 30 °C, the Ar gas pressure in the sputtering chamber is set to 3mTorr and the input power is set to 1kW.

The paragraph beginning on page 18, line 15 has been amended as follows:

In ~~the~~ medium B manufactured as explained above, since Cr is added to the magnetic layer 4', the Hc/Hk value of 0.3 has been obtained because the grain boundary region can be non-magnetized by segregating Cr included in the magnetic grains into the grain boundary on the occasion of deposition. However, the Ku value obtained has only been 7e+6(erg/cc).

The paragraph beginning on page 18, line 23 has been amended as follows:

The s~~S~~hape of the cross-section of ~~the~~ medium C is identical to that of medium A and is shown in Fig. 1. Moreover, the manufacturing process is as shown in Fig. 11, which is identical to the process of medium A. The o~~O~~nly difference from the manufacturing process of medium A is that the~~a~~ substrate is heated up to 250 °C when the magnetic film 4 is formed with the sputtering method.

The paragraph beginning on page 19, line 3 has been amended as follows:

From ~~the~~ medium C manufactured as explained above, the Ku value of 3.7e+6(erg/cc) has been obtained as in the case of medium A. However, diffusion of Cr into the grain boundary of the magnetic layer does not occur, and the Hc/Hk value has been reduced to 0.1 or less.

The paragraph beginning on page 19, line 8 has been amended as follows:

From the values of Ku and Hc/Hk of each medium manufactured as explained above, it can be understood that a comparatively larger Ku value can be obtained in ~~the~~ media A and C where Cr is not added to the magnetic layer, and moreover a large Hc/Hk value has been obtained in ~~the~~ medium A where the substrate is not heated when the magnetic layer is formed. From this result, it has also been confirmed that Cr should not be added to the magnetic layer to obtain a large Ku value, while the sputtering process should be conducted without heating the substrate in order to obtain a large Hc/Hk value.

The paragraph beginning on page 19, line 20 has been amended as follows:

In the present invention, since the Co based alloy in which Cr is not added is used as a material of the magnetic layer, the Ku value is maintained~~s~~ at higher value. Since the Ku value is high, the volume of crystal grains for starting deterioration of magnetic characteristic due to the thermal disturbance becomes small, and thereby reduction in the thickness of the magnetic film can be accelerated. As a result, an area of one bit can be reduced, and thereby high recording density can be achieved. Moreover, since the Cr-based alloy is used as the material of the underlayer, Cr can be diffused into the grain boundary of the magnetic layer from the underlayer. Since Cr is diffused into the grain boundary, the grain boundary of the magnetic layer can be non-magnetized. As a result, the magnetic mutual operation among grains can be controlled, and the noise of the magnetic recording medium can also be reduced.

The paragraph beginning on page 20, line 10 has been amended as follows:

As explained above, in the present invention, reduction in thickness of the magnetic layer and noise can be accelerated, and thereby high recording density of magnetic recording medium can be realized.

In the Claims:

Claims 4-6 have been cancelled, without prejudice; Claims 1-3 and 7 have been amended; and add new Claims 8-11 as follows:

1. (Once Amended) A magnetic recording medium, comprising:

an underlayer laminated on a substrate and including a Cr-based non-magnetic material ~~laminated on a substrate~~; and

a magnetic layer laminated on said underlayer, ~~allowing deposition of~~ including an alloy of at least ~~a kind of~~ one non-magnetic material and Co, ~~and also existence of~~ wherein Cr is present only at the ~~area near the~~ crystal grain ~~boundary~~ boundaries of said alloy.

2. (Once Amended) A magnetic recording medium, comprising:

an underlayer laminated on a substrate and including a Cr-based non-magnetic material; and

a magnetic layer consisting of a CoCr-based alloy including Cr in the concentration of 5at% or less.

3. (Once Amended) A magnetic recording medium according to claim 1, wherein said magnetic layer is formed of a Co alloy ~~structured with~~ consisting of two elements.

7. (Once Amended) A magnetic disc drive comprising:

a magnetic recording medium formed by laminating an underlayer including a Cr-based non-magnetic material ~~is laminated~~ on a substrate, depositing an alloy of at least ~~a kind of~~ one non-magnetic material and Co ~~and also laminating~~ to create a magnetic layer in which~~allowing existence of~~ Cr is present only at the ~~area near the~~ crystal grain~~s~~ boundaries of said alloy;

a spindle motor for rotating said magnetic recording medium;

a magnetic head for writing or reading data to or from said magnetic recording medium; and

an actuator for moving said magnetic head in the radius direction of said magnetic recording medium.

8. (New Claim) A magnetic recording medium, comprising:

a substrate;

an underlayer laminated on said substrate, said underlayer being composed of a Cr-based non-magnetic material and having a thickness in the range of between approximately 2nm to 14nm; and

a magnetic layer laminated on said underlayer, said magnetic layer being composed of a Co alloy, wherein Cr is present only at the crystal grain boundaries of said alloy.

9. (New Claim) A magnetic recording medium according to claim 1, wherein said underlayer has a thickness of greater than approximately 2nm.

10. (New Claim) A magnetic recording medium according to claim 2, wherein said underlayer has a thickness of greater than approximately 2nm.

11. (New Claim) A magnetic disc drive according to claim 7, wherein said underlayer has a thickness of greater than approximately 2nm.

In the Abstract:

The paragraph beginning on page 23, line 1 has been amended as follows:

A higher value of an anisotropic magnetic field can be acquired by using a magnetic material where Cr is not added as a material of a magnetic layer on which magnetic data is recorded. A magnetic recording medium ~~(1)~~ can be manufactured through the processes of laminating an underlayer ~~(3)~~ consisting of a Cr-based non-magnetic material on a substrate,~~(2)~~ and then laminating, on this underlayer, a magnetic layer ~~(4)~~ consisting of an alloy of at least ~~a~~ one kind of non-magnetic material that is different from Cr and Co.